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Impact of Cleaning Frequency on Nitrogen Balance in Open Feedlot Pens

Casey B. Wilson
University of Nebraska-Lincoln

Galen E. Erickson
University of Nebraska-Lincoln, gerickson4@unl.edu

Casey N. Macken
University of Nebraska-Lincoln

Terry J. Klopfenstein
University of Nebraska-Lincoln, tklopfenstein1@unl.edu

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Terry J. Klopfenstein[1]

Summary

Pen cleaning frequency of feedlot pens was evaluated during the summer of 2001 and 2002. Dry matter, organic matter and nitrogen recoveries were evaluated on a per head basis. Cleaning pens monthly compared to cleaning at the end of the feeding period resulted in significantly more DM, OM and N recovered. Cleaning pens every month increased N removal by 7.0 lb per steer (49.9% increase) above manure N removed at the end of the feeding period.

Introduction

Nitrogen losses or emissions from animal manure during collection, storage, and application are a concern for air quality, the environment and, potentially, human health. Methods that lower nitrogen (N) losses from manure will be important tools for producers in the future. One potential method to decrease N losses is to minimize protein fed in excess of requirements. By minimizing dietary protein to meet and not exceed requirements, N losses may be decreased (1999 Nebraska Beef Report, pp 60-63). Another potential method to lower N volatilization during manure storage is by manipulating the carbon to nitrogen (C:N) ratio.

Adding carbon to the manure increases microbial N immobilization, which reduces N losses. Carbon can be added in outdoor feedlot pens through bedding or by decreasing diet digestibility (2003 Nebraska Beef Report, pp 54-58). Losses of N with these various methods are not consistent across the year. Our hypothesis is that warm temperatures during the summer months results in rapid volatilization losses. The objective of this experiment was to evaluate pen cleaning frequency and the impact on N volatilization during the summer months when volatilization is the highest and during composting of manure.

Procedure

Cleaning frequency was evaluated during the summers of 2001 and 2002. Either monthly or end cleaning were evaluated. End cleaning refers to cleaning pens at the end of the feeding period. Monthly cleaning was performed every 28 days throughout the feeding period. In 2001, 432 yearling steers in 54 open feedlot pens receiving the same diet were utilized. The diet consisted of 40% wet corn gluten feed, 33% high-moisture corn, 7% alfalfa hay and 5% supplement. In 2002, 384 yearling steers in 48 pens were utilized with all pens receiving the same diet. The diet consisted of 35% wet corn gluten feed, 55% high moisture corn, 5% corn silage, 2% alfalfa hay and 3% supplement. The pen space per steer was equal in both years with 300 square feet per head. Pens were designated in each experiment as monthly cleaning or end cleaning. Within each cleaning frequency collected manure was composted.

Manure collected from pens was sampled at cleaning and weighed. Manure analysis was utilized to evaluate DM, OM and N recovery from the feedlot pen over the entire feeding period.

Nitrogen intake was calculated using dietary N concentration multiplied by DMI. Retained energy and protein equations established by the NRC (1996) were used to calculate steer N retention. Nitrogen excreted (urine plus feces) was determined by subtracting N retention from N intake. Manure N was calculated by multiplying DM removed per head by the percentage N in manure. Total N lost (lb/steer) was calculated by subtracting manure N from excreted N. Due to dry weather, little runoff occurred during either year of this experiment. However, runoff losses are generally small (2003 Nebraska Beef Report, pp 54-58) and were not quantified in these studies. Percentage of N lost was calculated as N lost divided by N excretion. All N values were converted to a lb/steer basis. Results were analyzed using the mixed procedure of SAS. Compost was sampled when composting was finished and OM and N recovery were evaluated based on cleaning frequency. Nitrogen recoveries in the compost were calculated using total ash as an internal marker and the following equation: Nitrogen recovery = 100 x [(% ash before ÷ % ash after) x (% N after ÷ % N before)]. Ash and N concentrations are on a DM basis. Dry matter and OM amounts were calculated similarly assuming no loss of ash, based on amounts removed at cleaning.

Results

The amounts of DM and N removed were increased if pens were cleaned monthly compared to cleaning at the end of the feeding period during summer (Table 1). By cleaning pens every month, N removal was increased 8.7 lb per steer or a 69.0% increase above manure N removed at the end of the feeding period in 2001. Monthly cleaning in 2002 increased manure N removal 5.5 lb per steer or a 34.8% increase above manure N

Table 1. Nitrogen mass balance per head in two years expressed in lb/steer.

	2001				2002			
Item	Monthly	End	SEM	P-value	Monthly	End	SEM	P-value
DM[a]	1464	803	64	<0.01	1529	1103	78	<0.01
OM[b]	440	230	10	<0.01	449	269	10	<0.01
N intake[c]	66.9	66.9	0.4	0.91	56.8	57.7	0.45	0.08
N retention[d]	8.7	8.7	0.1	0.73	8.8	8.4	0.1	<0.01
N excretion[e]	58.2	58.2	0.3	0.97	47.9	49.4	0.4	0.007
N manure	21.3	12.6	0.8	<0.01	21.3	15.8	1.0	<0.01
N loss[f]	36.9	45.6	0.7	<0.01	26.6	33.6	0.9	<0.01
N loss, %[g]	63.6	78.4	1.4	<0.01	55.5	68.0	1.7	<0.01

[a]DM manure recovered per steer over the entire period.
[b]OM manure recovered per steer over the entire period.
[c]Calculated using DMI and N concentration in the diet.
[d]Calculated using NRC (1996) net protein and net energy equations.
[e]Calculated as N intake minus N retention.
[f]Calculated as N excretion minus manure N.
[g]Calculated as N lost divided by N excretion.

Table 2. Compost analysis and nitrogen recovery for 2001 and 2002.

		Before Composting		After composting		
Frequency[a]	Date	N lb/head[b]	OM lb/head[b]	N lb/head[b]	OM lb/head[b]	N recovery
2001						
Monthly	June	5.3	128.3	3.1	67.4	58.8
Monthly	July	5.3	131.1	3.1	52.0	58.6
Monthly	August	4.0	97.8	2.2	32.4	53.6
Monthly	September	7.0	164.1	4.3	69.6	60.8
Total		21.6	521.3	12.7	221.4	58.0[c]
End	September	12.8	281.3	7.6	104.6	59.2
2002						
Monthly	June	4.9	129.6	2.7	50.1	56.5
Monthly	July	5.1	135.2	2.8	49.8	53.8
Monthly	August	5.9	154.2	2.9	54.2	49.0
Monthly	September	5.9	140.0	2.8	60.6	45.9
Total		21.8	559.0	11.2	214.7	51.8[c]
End	September	16.0	339.8	8.8	163.9	55.0

[a]Frequency signifies the pen cleaning frequency either monthly (28 day) or cleaning at the End.
[b]Values before and after composting have N and OM contributed from sawdust addition.
[c]Represents average recovery.

removed at the end of the feeding period. If manure is allowed to collect on pen surfaces during the entire feeding period, more N was exposed to the environment and available for volatilization. Intake of N was similar across treatments in both years ($P < 0.05$). Nitrogen retention in 2002 was lower for the end cleaning treatment than for monthly cleaning. Cattle on the end cleaning treatment consumed similar amounts of DM and gained less weight over the entire summer. Cattle on the end cleaning treatment started at significantly higher BW and had lower ADG. Lower ADG reduced N retention and impacted the total N excretion as well. Less nitrogen retention by steers with lower ADG and higher N intakes than steers on the 28 day cleaning treatment resulted in increased N excretion. Nitrogen excretion during the summer of 2001 was not different between treatments. The cattle allocation and performance were not part of this study. The cleaning frequency treatments were imposed on existing treatment blocks which led to differences in initial BW and ADG. We cannot conclude that cleaning frequency impacted performance. Manure N was significantly different between treatments for both years. Nitrogen loss was significantly higher for the end cleaning treatment than for the monthly cleaning treatment in both years. In conclusion, monthly cleaning was more effective in recovering N in manure and reducing the overall loss from the pen surface. Monthly cleaning reduced the total N loss to the environment by an average of 14%.

Nitrogen recovery percentages were evaluated after composting. N recovery was similar between pen cleaning treatments (Table 2). These data suggest if manure can be collected and windrowed to decrease surface area exposed to the atmosphere, cleaning pens more frequently may be a possible method to increase manure or compost N and decrease N losses. This method may be especially important during warm, summer months when volatilization losses are rapid and large.

[1]Casey B. Wilson, research technician, Casey N. Macken, research technician, Galen E. Erickson, assistant professor, Terry J. Klopfenstein, professor, Animal Science, Lincoln.